THE SNOWY OWL

EUGENE POTAPOV AND RICHARD SALE

Illustrations by
JACKIE GARNER

T & AD POYSER
London

CHAPTER 8
Numbers and population density

As described in Chapter 7, the Snowy Owl diet during the breeding season is almost exclusively large sized lemmings of the Dicrostonyx and Lemmus genera. Exceptions are rare, limited to the few occurrences when the owls are not breeding in good numbers (i.e. there are fewer breeding pairs because of poor lemming numbers and those birds which do breed take whatever prey is available), or where breeding was apparently accidental as the breeding site was inappropriate. Both lemming genera inhabit Arctic and sub-Arctic tundras where their numbers demonstrate cyclical variations both in time and space. The lemmings share their tundra vegetation habitat with other rodents and lagomorphs, and in addition to Snowy Owls are preyed upon by a number of other specialist as well as generalist predators – skuas, Arctic foxes and mustelids – which complicates their population dynamics. In this Chapter we set down our opinions as to why these cyclical fluctuations occur and what the implications of them are for Snowy Owl numbers and movements. Many interpretations of the cycles have been suggested, but for reasons of space, we focus on those which appear the most credible, particularly when considered against our personal observations at the Malaya Konkovaya study area of north-east Siberia where the primary prey of the Snowy Owl is the Siberian Lemming.

MEASURING SMALL MAMMAL POPULATION DENSITIES

Traditionally, the population density of small mammals has been measured with the help of snap-traps; a simple technology used throughout the tundra over many years (Yang *et al.* 1970; Tupikova & Emelyanova 1975; Chernyavsky & Tkachev 1982; Karaseva & Telitsina 1996). Unbaited traps are placed in lines in various habitats, preferably on lemming or vole runs in the vegetation, and checked regularly (Figure 8.1). During times of peak population, in our experience, it is necessary to check the traps immediately after the line is set, as some traps will already have caught a rodent before the remaining traps are set: again in our experience,

SNOWY OWL NUMBERS: A GUESSTIMATE

The total world population was estimated (Rich *et al.* 2004) to be as high as 300,000 individuals, with the North American population being 140,000 individuals (spread across the North American part of the range, an area of 2,959,211km^2). These figures are unrealistically high, and the range area was probably estimated as the area of the tundra biome. Simple extrapolation of the population density of the Snowy Owls which we observed (c. 25km^2 per pair) at the Malaya Konkovaya study area (c. 500km^2) over the entire range would only give 120,000 pairs across the entire world range. Such peaking conditions can be seen on continental tundras once in 10 years or so, but do not occur synchronously.

The distribution of Snowy Owls (see Figure 2.1) suggests that there are different areas within the range with different frequencies of breeding. The total maximum breeding numbers in the area of high probability of breeding (once in 3–9 years), which totals 1.34 million km^2 (see Chapter 2) with an assumed cyclicity of four years, gives a total of 1.34 million km^2/(25(km^2 per pair)×4) = 13,400 pairs. In the low probability of breeding areas (once in 10–29 years) the same logic estimates 4.1million km^2/(25×(once per 15 years) = 10,900 pairs, and in the extra-low probability of breeding (30–50 years) area of 6.59 million km^2, this gives us 7,500 pairs.

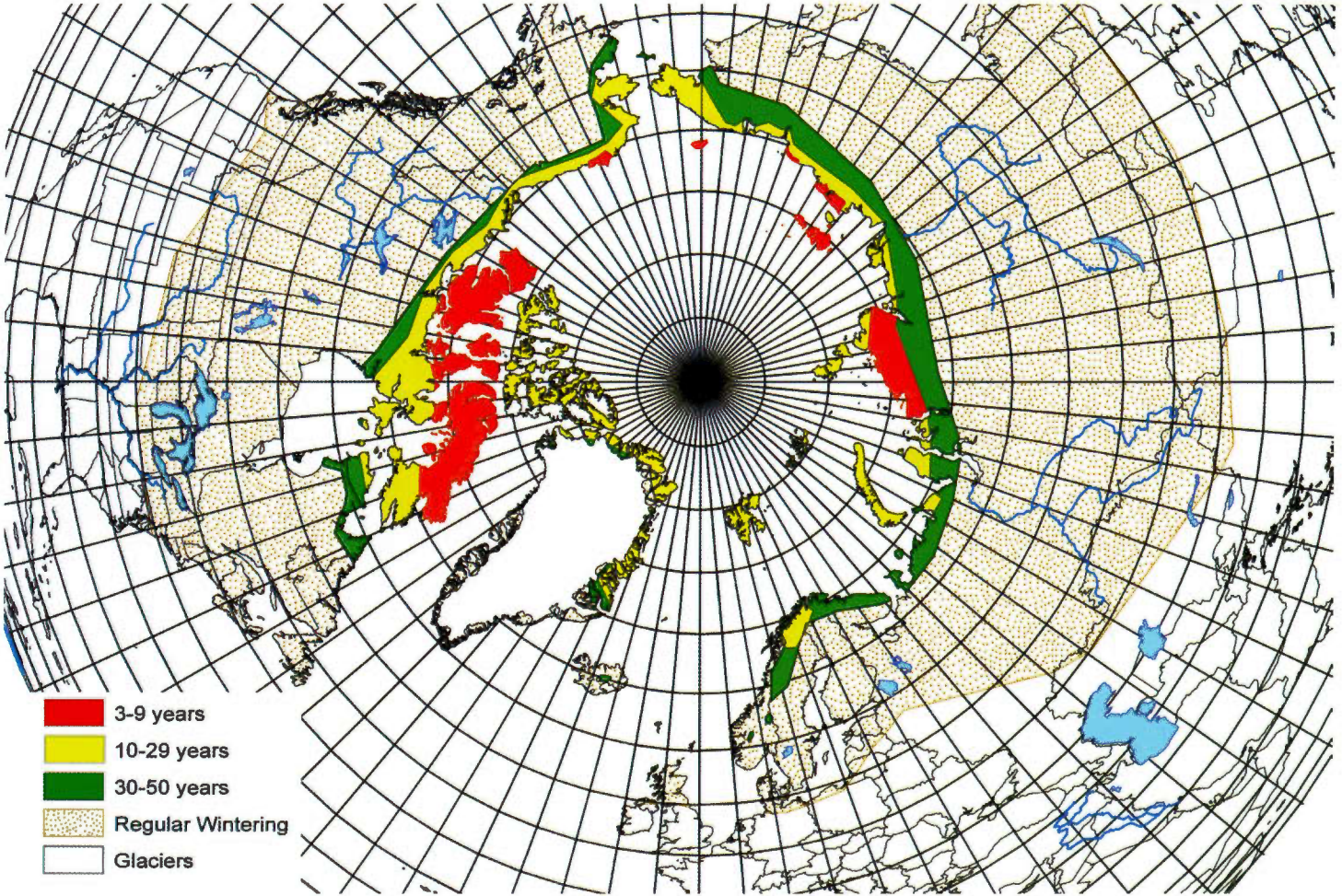
Thus the total potential number of Snowy Owls in the world based on the range area and average density and known frequency breeding probability is 31,800 pairs. This is a significantly lower number than the estimates by Rich *et al.* (2004), but still an overestimate in our opinion. We therefore consider a less 'broad-brush' approach.

A 'BREEDING POCKETS' APPROACH

Dispersed data on the breeding events of Snowy Owls, published in the Arctic Birds Bulletin and cumulative published literature, makes it possible to conclude that there are several breeding pockets of the species in the Arctic. Despite the significant gaps in the breeding range, the data allow us to outline some of these pockets geographically. In the Palearctic, favourable conditions for Snowy Owl breeding exist on Wrangel Island and Novosibirskiye (the New Siberian Islands) in almost all years except those of a deep lemming population depression, which occurs every four years. On the mainland there are usually up to three areas of the tundra where the lemming population might peak every year. Once every 4–10 years there may be an exceptionally poor year when owl breeding does not occur across the entire Palearctic tundra. In the Nearctic there may be up to three pockets of breeding Snowy Owls, and once in 4–10 years a poor year across the entire Nearctic tundra. Based on this, our conservative estimate of the total spring population would be 4 x 500 pairs for the Palearctic and 3 x 500 pairs for the Nearctic. These numbers give a total potential breeding population of 3,500 pairs. This population (7,000 owls) can, we estimate, be 2–3 times higher in the autumn after breeding. In a very good sequence of seasons that number might double. The recent trend away from lemming population cyclicity might generate very small breeding pockets (about 10 pairs) spread over large territories.

Figure 2.1. Distribution map.

The colours represent frequency of breeding in different regions in terms of frequency of nesting over the last 50 years (e.g. in red areas Snowy Owls have nested within the last 3-9 years etc) Winter range shows only regular records in the past 30 years. Extreme winter records are not shown for clarity.



A 'LOOSE BOID' APPROACH

The verification of any estimate of Snowy Owl population is a very difficult task, though interesting observations on a continental scale do allow us to assess the global population density of the species and so make an estimation of total numbers using a non-orthodox approach.

In 1994 the Swedish Polar Research Secretariat financed the joint Swedish-Russian expedition 'Tundra Ecology–94', the research ship *Academician Fedorov* making a trans-continental transect of all Arctic tundras from the Kola Peninsula to Chaun Bay (Alerstam & Jönsson 1999). Among other things, the expedition provided records on Snowy Owl breeding events. During the transit of the Russian Arctic the researchers found only 63 pairs of Snowy Owls (Isakson *et al.* 1995), the nests mostly concentrated on Wrangel Island and Novosibirskiye, and at the Yana and Indigirka estuaries. In other places, from the Kola Peninsula to the Lena River, no breeding owls were found.

In 1999 a similar transit of the North-West Passage was carried out by the Swedish Polar Research Secretariat (Krebs *et al.* 2002). The trip coincided with a low lemming population phase and no Snowy Owl nests were reported.

In the same year as the *Academician Fedorov*'s transect (1994), some of the study plots were also visited by a team of Russian and American ornithologists surveying birds from the air (Poyarkov *et al.* 2000). The surveys were financed by the US Fish and Wildlife Service within the framework of the US-Russian 'Studies of the Northern Migratory Waterfowl' Agreement set up in 1974 by legendary Arctic researchers Alexander Kishinskiy and Bill Sladen. The agreement was signed during the period in which the USSR was perhaps at its mightiest, and capable of large-scale work. But by the time the surveys took place in the early 1990s the Soviet Union was disintegrating, the irony being that these truly large-scale efforts were made possible only during years when the infrastructure of the Russian Arctic was collapsing.

The team surveyed waterfowl numbers over a large fraction of the tundra from Chukotka to the Indigirka lowlands during 1993–95. In 1994 the survey included a portion of the tundra close to that of the Swedish-Russian survey, the only instance of a substantial section of tundra being surveyed by two independent teams. The aerial team extrapolated their surveys for the area between the Indigirka and the Kolyma rivers to a figure of 4,871±1,024 (SE) individual Snowy Owls in an area of 99,280km^2 (Poyarkov *et al.* 2000). It is our view that this survey covered two pockets of breeding: one at the Yana River, the other at the Indigirka River. In 1995, when there was a deep lemming population depression, the aerial survey in the same area returned a figure of 635 owls.

The results of this work can be coupled with the results of tundra monitoring by the Wader Study Group mentioned above. The group publishes yearly observations filed by individuals who have either visited an Arctic region, or are stationed there. Although the Study Group does not cover the entire Arctic, their records are of exceptional value. The small numbers of owls noted have to be extrapolated to a huge territory, but the Poyarkov data represents, to our knowledge, the first attempt to make a scientifically based estimate of the total number of Snowy Owls.

These surveys represent no more than snapshots, and are useful only in establishing the credibility of total population estimates. As the population of Snowy Owls varies both spatially and temporally, estimating its size is akin to standing beneath a locust swarm and counting insects, but with no knowledge of how long ago the front of the swarm past or how far away the swarm's rear is. We would argue that Snowy Owls resemble such a swarm, but with one crucial difference – the owls must slow down to breed and their breeding decision will depend on the local abundance of small rodents of particular body mass, and their ability to reach such

localities in early spring. The outcome depends on the owls' wintering locations and their ability to detect rodent trends. It is a stochastic process.

But as we suspect that Snowy Owls live in loose aggregations (loose boids – see Chapter 5), their appearance on the breeding grounds, if favourable conditions are met, is usually gregarious and that allows us to estimate a total population. If you see one owl starting to breed, most likely you will see other owls breeding nearby. Earlier breeders will occupy the best habitats; later breeders will be breeding at the fringes of such areas with respectable differences in the age of chicks. Such breeding patches are obvious on continental tundras, though less evident on Arctic islands. Since the probability of breeding of such loose boid aggregations within the range is not the same (see Chapter 2), the task of estimating the total numbers of Snowy Owls can be approached by estimating the probability of a boid breeding in a particular area and integrating this spatial probability for the entire range.

On our loose boid model, the mechanism of tundra occupancy is as follows: the initial start of the breeding population is originated by adult owls wintering in the tundra zone – some satellite-tagged owls behaved exactly that way (see Chapter 9). Perhaps the owls also winter in loose boids and as soon as they reach a place with active winter lemming breeding, they decide to stay. More owls arrive in spring and settle on the fringes of the original boid. The peripheral nests of the boid tend to have later clutches, consistent with our observations in Russia's Lower Kolyma. The breeding boid stops growing, either when there are no new arrivals, or when newly arrived birds are unable to find good habitat with sufficient food. The survey data listed above suggests that the axis of such a boid rarely exceeds 300km. If there are no lemmings in an area, the birds continue across the tundra until they do find an area with a supply of lemmings. If they fail to do so, either they die or find an area where the rodents are abundant enough to keep them alive, but not abundant enough for clutch formation. Menushina (2007) mentioned that in the years when the Snowy Owls do not breed on Wrangel Island, their density increases on the continental tundras near Cape Schmidt settlement, indicating that the boid shifts to the mainland and stays there for the summer.

Tenet (1963) and Miller, with co-authors, (Miller & Russell 1973; Miller *et al.* 1975; Miller 1987) covered a significant portion of the Canadian Arctic while making aerial surveys of caribou and muskoxen. As a by-product they reported the density and locations of Snowy Owls on several large islands. The surveys counted individual owls only, so it was not possible to assess the breeding situation, nests either being missed or not being visible during the surveys. The coverage of the surveys was large enough to include significant portions of what we call loose breeding boids. When surveying the eastern part of Melville Island in 1961 and 1972 it was reported that the owls were not distributed evenly across the island, the core density being located in the western part of the island. Owls were breeding across all surveyed areas in 1972, but were missing in the central part of the surveyed area. The area surveyed was c. 280km along the longest axis of the island. The entirety of Melville Island, as well as nearby Eglinton Island (to the west) and Byam Martin Island (to the east), were covered by the aerial surveys of 1972–74. The longest axis of the area covered was c. 450km. Although Snowy Owls were breeding across all three islands, the densest breeding was observed in 1973 on the western part of Melville Island and on Eglinton Island, and in 1974 on the northern part of Melville Island. Such large-scale observations are invaluable since they clearly demonstrate that the loose breeding boid might shift its core area to follow the lemmings. In 1985 (lemmings abundant) and 1986 (lemmings sparse) (Miller 1987) the surveys covered nine central and three eastern Queen Elizabeth Islands, the surveyed area with (presumably) breeding owls was c. 360km along the longest axis, and the boid which was (presumably) breeding there was estimated to have been 932 individuals in 1985 when the core area of the boid was Bathurst Island. In the

following year there was evidently no breeding on Bathurst Island, and the owl density reduced a hundredfold.

We assume that the overall population structure in spring and early summer consists of some five to ten separate boids, each of 300 to 2,000 pairs, moving through the tundra zone in the hope of hitting good breeding locations. The aggregation of breeding owls in Fennoscandia in 2011 (see Chapter 2 and Jacobsen *et al.* 2011) supports this hypothesis.

Golovatin and Paskhalniy (2005) made an estimate of the total number of Snowy Owls in the Gydan and Yamal peninsulas when breeding occurs there. Our view is that, geographically, the peninsulas represent an area occupied by a single boid. According to Golovatin and Paskhalniy there were at least 2,500–3,000 breeding pairs, with a further 1,500–2,000 non-breeding individuals, giving a total owl population of 6,000–8,000 individuals, though they stress this is a very imprecise estimate as it was made by extrapolating from very few discovered nests (just 15). We consider this to be close to our estimation of boid size, i.e. about 2,000 individuals (one boid for Yamal and another for the Gydan Peninsula).

Official estimates of the owl population in any year are available for Scandinavia, which is perhaps one of the most monitored regions of the species' range. For Finland the total number was estimated as 0–100 pairs, Norway 1–20 pairs and Sweden 1–50 pairs (Koskimies 1998). For Russia the figures vary drastically, but according to Birdlife International the estimated total number for the European part of Russia is 1,300–4,500 pairs, with Greenland having 50–1,000 pairs. Millsap and Allen (2006) estimated the total number of Snowy Owls in the USA (Alaska and contiguous US) in 2003–4 as 72,500 individuals. Commenting on their methodology the authors say they 'eliminated the ad hoc visibility correction factor employed by Rich *et al.* (2004) that doubled population estimates derived from breeding bird survey (BBS) counts under the general assumption that 50% of individuals were not detected because they were incubating or brooding on nests.'

By assessing the observations reported by the Arctic Wader Study Group, old literature breeding data, results of continental transects coupled with aerial surveys (Krebs *et al.* 2002; Jönsson and Alerstam 1995; Alerstam and Jönsson 1999; Poyarkov *et al.* 2000; Miller & Russel 1973; Miller *et al.* 1975, 1987), migration patterns (see Chapter 9), and the fact that the owls, when they breed form a loose boid with 5–7km (sometimes more) distance between the pairs (to be able to maintain signalling (see Chapter 1), habitat permitting, we consider that there is a limited number of boids moving across the Snowy Owl range. We also consider these boids constitute the bulk of the breeding population of the Snowy Owls. We consider one boid is located in northern Europe, moving from Scandinavia to Novaya Zemlya and to the Taymir Peninsula. Another boid moves east from Taymir to the Kolyma River in Chukotka. A third boid occupies the tundra between the Indigirka River and Canada's Victoria Island. Two further boids live on Wrangel Island and Novosibirskiye. Finally one boid, which is probably the largest (we tentatively estimate it at 4,000 pairs), occupies central northern Canada, including the Canadian Archipelago, while another occupies Greenland. We believe the boids may mix and split again, but that the basic idea of seven boids, each totalling about 2,000 pairs (the number may grow in good years, decline in bad ones), will give a best estimate of the average world population of Snowy Owls, i.e. a total of 14,000 pairs. The very conservative estimate is about half this number, i.e. 7,000–8,000 pairs. After a very successful year this population could double, but in years of depressed population may be reduced to as little as 5,000 pairs.